Journal of Public Health | Vol. 41, No. 1, pp. e35–e43 | doi:10.1093/pubmed/fdy096 | Advance Access Publication June 11, 2018

Does the density of the health workforce predict adolescent health? A cross-sectional, multilevel study of 38 countries

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ABSTRACT

Background Scant evidence exists on the relation between the availability of health professionals and adolescent health, and whether the size of the health workforce equally benefits adolescents across socioeconomic strata.

Methods We conducted a cross-sectional analysis of adolescent health in 38 countries. Data from 218 790 adolescents were drawn from the 2013/2014 Health Behavior in School-aged Children survey. We used multilevel regression analyses to examine the association between the density of the health workforce and psychosomatic and mental health symptoms with differences in country wealth and income inequality controlled.

Results A higher density of psychologists was associated with better self-reported mental health in adolescents ($P = 0.047$); however, this finding was not robust to sensitivity analyses. The densities of physicians and psychiatrists were not significantly associated with better adolescent psychosomatic or mental health. Cross-level interactions between the health workforce and socioeconomic status did not relate to health, indicating that larger health workforces did not reduce socioeconomic differences in adolescent health.

Conclusions This study found that adolescents in countries with a higher density of health providers do not report better psychosomatic or mental health. Other social or structural factors may play larger roles in adolescent health.

Keywords health services, mental health, young people

Introduction

Adolescence is generally regarded as a period of good health. However, research has found that despite being relatively free of serious illness, ~28–35% of adolescents report multiple psychosomatic health symptoms at least once per week.[1] In turn, psychosomatic symptoms are associated with poor mental health[2] and lower educational attainment in adulthood.[3] Identifying the determinants of psychosomatic symptoms in adolescents, and of health more generally, constitutes an important means of assuring optimal health throughout the lifespan.

The health workforce is foundational to health systems and an important structural determinant of health.[4] According to the World Health Organization (WHO), the primary goal of health systems is to improve overall population health,[5] and the United Nations Sustainable Development Goal (SDG)

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3.C calls for improvements in health through sustainable expansion of the health workforce.[6] Specifically, SDG Target 3.C.1 is 'health worker density and distribution'.[6] Thus, one issue that has received considerable interest is whether the density of the health workforce in an area relates to population health. This line of inquiry assumes that the provision of greater health resources will increase access to care and lead to better population health. Although early studies found no effect or a negative effect of the density of the health workforce on population health,[7–9] more recent studies have found a positive relationship at country and regional levels, independent of area-level wealth.[10–16]

In addition to improving overall population health, health systems are also designed to reduce health inequalities[5] through efforts such as expansion of insurance coverage, targeted health policies and public health interventions. These strategies may increase average population health by narrowing health inequalities, as disadvantaged groups tend to have worse baseline levels of health, and accordingly, the most to gain from increased access to health care.[17] Consequently, the impact of health systems on health inequalities is of increasing interest to both national and international policy makers who seek to reduce health disparities.[18]

The relationship between health care and population health has been studied extensively, however, less is known about how health services provision relates specifically to adolescent health. The available evidence suggests that unmet need for care or poor quality care may worsen health in adolescence and thus the health of a future generation of adults,[19,20] and that improved access to care for adolescents can have long-term health benefits.[21] However, a large ecological study found no relationship between country-level health expenditure and indicators of adolescent health, including rates of smoking, teenage births and mortality.[22] Further research is necessary to identify which aspects of health systems, including the health workforce, predict adolescent health.

This study was a cross-national analysis of country-level and individual-level adolescent data from 38 countries. Our objectives were to (1) examine the relation between the density of the health workforce (physicians, psychologists and psychiatrists) and self-reported psychosomatic and mental health in adolescents and (2) determine the extent to which the density of the health workforce relates to socioeconomic inequalities in adolescent health. We hypothesized that a greater density of the health workforce at the country level would relate to better health and narrower health inequalities between socioeconomic groups, after controlling for country wealth and structural income inequality.

Methods

Participants

Participants were drawn from the 2013/2014 cycle of Health Behavior in School-aged Children (HBSC) study, a school-based, cross-national survey of adolescents ages 11, 13 and 15 in Europe and North America from 42 countries and regions. Greenland was excluded because country-level data for the predictors of interest were unavailable. The Flanders and French regions of Belgium and England, Scotland and Wales were collapsed into Belgium and the UK, respectively. Overall, our sample included 218 790 adolescents from 7172 schools in 38 countries. The sample was evenly distributed between gender groups (50.7% female). The survey used a standardized questionnaire and two-stage cluster sampling of schools representing the regional, economic and public/private distribution of schools in each country.[23] Supplementary Table S1 contains details regarding the country-level variables for each country, including the year of data extraction and the number of participating adolescents and schools. Each member country obtained ethics approval to administer the survey from a university-based ethics review board or an equivalent monitoring body. This study is reported according to the STROBE guidelines for observational studies.[24]

Country-level data

Data for the health workforce were drawn from the WHO Global Health Workforce statistics database. These data are accumulated from censuses, labor force and employment surveys, and other administrative information systems. Data were extracted for the number of general physicians per 10 000 population. Data for the health workforce for mental health were drawn from the WHO Mental Health Atlas for 2014.[25] These data were collected through a standardized questionnaire disseminated to ministries of health within WHO member nations. Data for the number of psychiatrists and the number of psychologists per 10 000 people were extracted. Data from 2014 were unavailable for 13 and 8 countries for the density of psychiatrists and psychologists, respectively, and we substituted data from the next most recent survey (2011).

Data for national wealth were obtained in the form of gross national income (GNI) per capita adjusted for purchasing power parity (current international $) from the World Bank DataBank. Data for income inequality were obtained in the form of Gini coefficients from the United Nations University World Institute for Development Economics Research—World Income Inequality Database

(version 3.3). In line with previous studies,[10] we controlled for country wealth and income inequality in all analyses that included country-level variables.

Individual-level data

Health was assessed using the 8-item HBSC-symptom checklist.[26] This scale measures the frequency of four psychological health symptoms (irritability or bad temper, feeling nervous, difficulties in getting to sleep and feeling low) and four somatic ones (headache, stomachache, backache and feeling dizzy) over the past 6 months. Each item is scored on a 5-point scale, ranging from 1 (about every day) to 5 (rarely or never). A total score ranging from 8 to 40 is obtained by summing the item scores, with higher scores indicating better health. A separate score representing mental health was obtained by summing the four psychological symptom items, with scores ranging from 4 to 20.[27] The HBSC-symptom checklist and the psychological symptom subscale were shown to be valid and reliable global measures of psychosomatic and psychological health in adolescents.[26,27]

Previous studies found considerable international variation in social determinants of adolescent health,[28] and thus, we controlled for relevant individual- and country-level covariates in our analyses. At the individual level, these included age, gender and socioeconomic status (SES). SES was measured using the HBSC Family Affluence Scale, which is an index of six material indicators of family wealth, namely, family vehicle ownership, having a bedroom to oneself, computer ownership, number of household bathrooms, presence of a dishwasher and number of family vacations in the past year.[29] Total scores were transformed to country-specific quintile groups.

There were limited missing data, and the methods used to handle these are outlined in Supplementary File 1.

Data cleaning and analysis

Standardized data weights were applied to account for small variations in sampling between countries and for the a priori combining of HBSC samples in Belgium (Flemish and French regions) and the UK (England, Scotland and Wales). We fitted 3-level linear models to test the association of the health workforce density and adolescent health. Each model specified three levels of variation: adolescents (i) nested in schools (j) nested in countries (k):

$$y_{ijk} = \beta_0 + \beta_1 x_{1ijk} + \beta_2 x_{2ijk} + \beta_3 x_{3ijk} + \beta_4 x_{4k} + \beta_5 x_{5k} + \beta_6 x_{6k} + \nu_{0k} + \mu_{0jk} + \epsilon_{0ijk}$$

Models of health (y_{ijk}) included fixed effects of gender (x_{1ijk}), age (x_{2ijk}) and SES quintile (x_{3ijk}), and at the country level, GNI (x_{4k}), the Gini coefficient (x_{5k}), and the density of the health workforce (x_{6k}). Random effects were included at the country-level (ν_{0k}) and school-level (μ_{0jk}). We modeled psychosomatic health as the dependent variable with the density of physicians as a predictor and modeled mental health as the dependent variable with the density of either psychologists or psychiatrists as the predictor. For each health model, we first tested the associations of individual characteristics with the dependent variable (model 1). We then entered country-level variables (model 2). Lastly, we entered cross-level interactions of SES with the density of the health workforce (physicians, psychologists or psychiatrists) to test moderating effects of the health workforce on socioeconomic differences in health (model 3). We assessed model fit using Akaike's Information Criterion (AIC) and the Bayesian Information Criterion (BIC)[30] and we compared model deviance using likelihood-ratio tests. The analyses were carried out using *xtmixed* in STATA 14.2.

Results

Descriptive statistics for the individual-level variables and country-level variables are shown in Table 1. Psychosomatic and mental health were highly correlated to one another ($r = 0.91$, $P < 0.05$) and weakly correlated with age ($rs = -0.16$, $Ps < 0.05$). Wide variations were found in country wealth

Table 1 Individual- and country-level descriptive statistics

	Mean	*SD*	*Range*
Individual level			
1. Psychological health	15.07	4.11	4.00, 20.00
2. Psychosomatic health	31.71	6.79	8.00, 40.00
3. SES	13.78	2.65	4.00, 19.00
4. Age	13.63	1.63	10.50, 16.50
Country level			
1. Income per capita ($, thousands)	33.55	15.60	5.35, 70.75
2. Income inequality	30.55	4.85	22.9, 43.2
3. Physicians per 10 000[a]	32.62	76.95	11.45, 49.49
4. Psychologists per 10 000[b]	1.58	2.45	0.04, 9.08
5. Psychiatrists per 10 000	1.29	0.77	0.13, 4.14

Note. [a]n = 37 countries. [b]n = 32 countries. SD = standard deviation; SES = socioeconomic status. Countries included in this study are Albania, Armenia, Austria, Belgium (French and Flemish regions), Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Moldova, Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, UK (England, Scotland and Wales).

(income per capita) and income inequality, and these variables were moderately correlated with health workforce, with country wealth positively correlated with the density of psychologists ($r = 0.56$, $P < 0.05$) and psychiatrists ($r = 0.66$, $P < 0.05$) and income inequality negatively correlated with the density of psychiatrists ($r = -0.35$, $P < 0.05$).

We first tested a multilevel model to examine the association of individual characteristics and self-reported psychosomatic health (Table 2; model 1). Psychosomatic health related negatively to female gender and age, and positively to SES ($P < 0.01$). When country-level predictors were added, we found that the density of physicians did not predict psychosomatic health (model 2), and in addition, the cross-level interaction term between SES and the density of physicians did not explain variability in psychosomatic health (model 3). We then tested similar models with either the density of psychologists or psychiatrists predicting mental health (Table 3). Individual-level covariates had comparable relationships with mental health as they did with psychosomatic health (model 1), and interestingly, the addition of country-level predictors (model 2) showed that the density of psychologists had a small but statistically significant positive association

Table 2 Multilevel analysis of adolescent psychosomatic health predicted by the density of physicians (n = 188 539)

	Model 1		*Model 2*		*Model 3*	
	B	*SE*	B	*SE*	B	*SE*
Fixed effects						
Intercept	39.12**	0.52	39.71**	1.92	39.43**	2.03
Gender						
Female	(ref)		(ref)		(ref)	
Male	2.71**	0.07	2.71**	0.07	2.71**	0.07
Age	−0.67**	0.04	−0.67**	0.04	−0.67**	0.04
SES						
First quintile	(ref)		(ref)		(ref)	
Second quintile	0.39**	0.06	0.39**	0.06	0.58*	0.27
Third quintile	0.57**	0.09	0.57**	0.09	1.10**	0.40
Fourth quintile	0.58**	0.09	0.58**	0.09	0.94*	0.44
Fifth quintile	0.52**	0.12	0.52**	0.12	0.86	0.69
Density of physicians			0.00	0.02	0.01	0.03
GNI			−0.02*	0.01	−0.02*	0.01
Gini coefficient			0.00	0.04	0.00	0.04
SES × density of physicians						
First quintile					(ref)	
Second quintile					−0.01	0.01
Third quintile					−0.02	0.01
Fourth quintile					−0.01	0.01
Fifth quintile					−0.01	0.02
Variance components						
$\sigma^2_{\nu 0}$ (country)	1.32	0.29	1.22	0.28	1.22	0.28
$\sigma^2_{\mu 0}$ (school)	0.97	0.07	0.97	0.07	0.98	0.07
σ^2_{e} (adolescent)	40.91**	0.86	40.92**	0.86	40.91**	0.86
ICC (country)	0.03	0.01	0.03	0.01	0.03	0.01
ICC (school)	0.05	0.01	0.05	0.01	0.05	0.01
Goodness of fit						
AIC	1 239 043.4		1 239 046.7		1 239 046.9	
BIC	1 239 144.9		1 239 178.6		1 239 219.4	
Deviance	1 239 023.4		1 239 020.7		1 239 012.9	
LR test versus model 1			2.68		10.50	

Note. AIC = Akaike's Information Criterion; BIC = Bayesian Information Criterion; GNI = Gross National Income; ICC = intraclass coefficient; LR = likelihood-ratio; SE = standard error; SES = socioeconomic status. *$P < 0.05$. **$P < 0.01$.

with mental health (beta coefficient (B) = 0.09, P = 0.047). This suggests that every additional psychologist per 10 000 population was associated with a 0.09 higher mental health score in the adolescent population. However, the Netherlands had a density of psychologists that was greater than three standard deviations from the mean, and when we removed this country from our analyses, the density of psychologists was no longer significantly associated with mental health (B = 0.11, P = 0.115; Supplementary Table S2). Figure 1 shows the predicted mental health score as a function of the density of psychologists across all countries. The cross-level interaction term between SES and the density of psychologists did not explain additional variation in mental health (model 3), which indicates that the effects of the density of psychologists on mental health did not differ significantly across SES groups. The density of psychiatrists did not predict mental health (model 2), nor did the interaction with SES (model 3).

Table 3 Multilevel analyses of adolescent mental health predicted by the density of psychologists (n = 164,256) or psychiatrists (n = 193 620)

	Models with psychologists						*Models with psychiatrists*					
	Model 1		*Model 2*		*Model 3*		*Model 1*		*Model 2*		*Model 3*	
	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*	B	*SE*
Fixed effects												
Intercept	19.52**	0.41	19.37**	0.84	19.38**	0.85	19.39**	0.35	19.83**	0.84	19.79**	0.86
Gender												
Female	(ref)		(ref)		(ref)		(ref)		(ref)		(ref)	
Male	1.47**	0.05	1.47**	0.05	1.47**	0.05	1.45**	0.05	1.45**	0.05	1.45**	0.05
Age	−0.39**	0.03	−0.39**	0.03	−0.39**	0.03	−0.39**	0.02	−0.39**	0.02	−0.39**	0.02
SES												
First quintile	(ref)		(ref)		(ref)		(ref)		(ref)		(ref)	
Second quintile	0.20**	0.04	0.20**	0.04	0.21**	0.04	0.23**	0.04	0.23**	0.04	0.28**	0.07
Third quintile	0.28**	0.06	0.28**	0.06	0.27**	0.05	0.31**	0.05	0.31**	0.05	0.35**	0.10
Fourth quintile	0.33**	0.06	0.33**	0.06	0.33**	0.06	0.35**	0.05	0.35**	0.05	0.45**	0.10
Fifth quintile	0.33**	0.09	0.33**	0.09	0.28**	0.07	0.37**	0.08	0.37**	0.08	0.43**	0.16
Density of health workforce			0.09*	0.05	0.09	0.06			−0.04	0.14	0.00	0.13
GNI			−0.02*	0.01	−0.02*	0.01			−0.01	0.01	−0.01	0.01
Gini coefficient			0.02	0.02	0.02	0.02			0.00	0.02	0.00	0.02
SES × density of psychologists												
First quintile					(ref)						(ref)	
Second quintile					−0.01	0.01					−0.04	0.04
Third quintile					0.01	0.03					−0.03	0.07
Fourth quintile					0.00	0.03					−0.07	0.06
Fifth quintile					0.03	0.04					−0.05	0.11
Variance components												
σ^2_{v0} (country)	0.41**	0.10	0.34**	0.08	0.34**	0.08	0.43**	0.09	0.40**	0.09	0.40**	0.09
$\sigma^2_{\mu 0}$ (school)	0.39**	0.04	0.39**	0.04	0.33**	0.04	0.37**	0.03	0.37**	0.03	0.37**	0.03
σ^2_e (adolescent)	15.19**	0.26	15.19**	0.26	15.19**	0.26	15.27**	0.28	15.27**	0.28	15.27**	0.28
ICC (country)	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01
ICC (school)	0.06	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
Goodness of fit												
AIC	916 786.5		916 787.1		916 787.2		1 081 535.7		1 081 539.0		1 081 543.8	
BIC	916 886.6		916 917.2		916 957.4		1 081 637.4		1 081 671.3		1 081 716.7	
Deviance	916 766.5		916 761.1		916 753.2		1 081 515.7		1 081 509.8		1 081 513.0	
LR test versus model 1			5.46		13.33				2.68		5.91	

Note. AIC = Akaike's Information Criterion; BIC = Bayesian Information Criterion; GNI = Gross National Income; ICC = intraclass coefficient; LR = likelihood-ratio; SE = standard error; SES = socioeconomic status. *P < 0.05. **P < 0.01.

We observed low intraclass correlations (ICCs) at school and country levels of variation, indicating that most of the variance in health occurred at the adolescent level. Variance inflation factors (VIFs) did not exceed 2.20, indicating that our results were not affected by multicollinearity.[31] AIC and BIC values were consistently the lowest in models containing only individual-level variables.

Discussion

Main finding of this study

The governments of the world have agreed to work towards a common SDG goal of better health and wellbeing though the sustainable expansion of the health workforce.[6] Implicit in this approach—indeed in most health policy—is the assumption that larger workforces contribute to better population health. This study tested this assumption in pediatric populations by examining the relation between health workforce density and self-reported health in a cross-national sample of adolescents from 38 countries.

Our first hypothesis, that an increased density of the health workforce relates to better adolescent health, was partially supported. The density of physicians on a national level did not relate to psychosomatic health in adolescents, and the density of psychiatrists did not relate significantly to mental health. Initially, an increasing density of psychologists did predict better adolescent mental health, however, this association appeared to be driven by an outlying observation and should therefore be interpreted with caution. Support was not found for our second hypothesis either. The density of the health workforce did not relate to socioeconomic differences in adolescent health.

What is already known on this topic

Numerous studies have found that a larger health workforce relates to better population health.[10–16] However, few studies have examined the relationship between different characteristics of health systems and adolescent health, and those that have obtained mixed results.[19–22] Many policy interventions assume that a larger health workforce will lead to better population health, but the relevance of these policies to adolescent health is unclear. Furthermore, the mechanisms by which health systems interact with health inequalities remain understudied, despite significant application to health policy.[18]

What this study adds

Our study adds to the existing body of evidence by examining the association between the density of three types of health professionals and psychosomatic and mental health in adolescents, an understudied population in public health.[32] Our findings conflict with previous studies,[10–16] as we observed only weak or null associations between the health workforce and adolescent health. There are numerous reasons why this may be the case. First, the available evidence suggests that social and environmental factors, such as access to education and employment, are the strongest determinants of adolescent health, whereas health systems determinants may be relatively less important in predicting health in this population.[22] Similarly, adolescents are less likely than other age groups to be insured and to make use of preventative health care,[33] and thus, structural features of health care systems may not relate to adolescent health in the context of low access to care and unwillingness to seek care. Finally, the distribution of health care resources, access and heathcare information may not be equally distributed among age groups and adolescents may be underserved in this respect. A recent survey of child and adolescent mental health services in Europe found large heterogeneity across 28 countries in resource allocation with no match to epidemiological burden (e.g. service availability, inpatient beds).[34] Thus, resources may not be distributed in relation to need for care, and this could explain the lack of an association between the density of psychiatrists and mental health, as well as the weak association with the density of psychologists. On the other hand, because we relied on proxy measures of diagnoseable conditions, these findings may not replicate when other methods and indicators are used and therefore should not be considered universal.

In line with extant research,[35] we observed a graded relationship between SES and health, where adolescents in higher SES quintiles reported better health compared to the lowest SES quintile. In addition, contrary to our hypothesis, countries that had a higher density of health professionals did not appear to have smaller SES gaps in health. This finding suggests that increasing the availability of health services at the country-level may not be an effective strategy for reducing health inequalities among adolescents, just as it does not seem to be an effective strategy for raising average levels of adolescent health. Policies that specifically target youth populations from socioeconomically deprived communities may be needed to impact adolescent health. Although we found no such association with adolescents' health—independent of country wealth and income inequality—it remains possible that increased country wealth improves adolescent health and reduces health inequities through the health sector. Overall, inequalities in adolescent health are rising,[36] and thus, identifying viable methods to halt and reverse this growth is imperative. Adolescents from poor

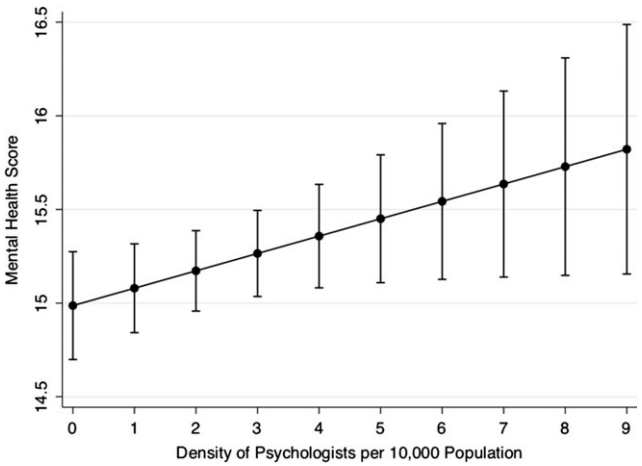

Figure 1 Predicted mental health score as a function of the density of psychologists per 10 000 population, with all covariates held constant at their mean.

families are at high risk for adverse health outcomes, and yet they are routinely excluded from accessing services that could provide help.[37] Moving forward, health ministries and policy makers must consider the needs of the most vulnerable adolescents and ensure that health services are accessible to all.

Health systems can be characterized in terms of both quantity and quality. This study exclusively examined a quantitative aspect of health care and thus cannot inform inferences pertaining to mechanisms by which the quality of health care influences adolescent health. However, the available evidence suggests that the quality of health care for adolescents is suboptimal.[19,20] Adolescence is a key period for health care professionals to curtail poor health behaviors that track into adulthood, and negative experiences with health care could limit this potential.[38] Therefore, future studies should also investigate the correlates of positive experiences with health care professionals so that the return from these interactions can be maximized.

Limitations of this study

Three key limitations of this study should be noted. First, the sample of countries was small and mostly composed of high-income European countries, which limited our ability to include covariates at the country level and to generalize the results to low- and middle-income countries. Wide variation in densities of health professionals and the cross-sectional design might have also contributed to the lack of an association between the health workforce and socioeconomic health disparities. Second, the outcomes in this study were based on self-reported data that serve as a proxy for diagnosable conditions. Although HBSC survey measures have been rigorously evaluated, there are biases inherent to self-report measures that could have affected our results. Increases in self-reported symptoms may be less likely to necessitate professional health care use than increases in diagnosable health problems, and this may be an additional reason for the weak observed associations. Third, there are large differences between countries in the way that health care is delivered. Because our study used quantitative data, we were unable to capture the heterogeneity that exists between and within countries in the roles of health professionals. Future research should capitalize on the increasing availability of international health data to test potential associations between health systems and health disparities measured via different methods.

Conflicts of interest

None declared.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Acknowledgements

The HBSC is a World Health Organization/Euro collaborative study; International Coordinator of the HBSC study is Jo Inchley, University of St. Andrews, Scotland; Data Bank Manager is Oddrun Samdal, University of Bergen, Norway. The HBSC countries involved in this analysis (current responsible principal investigator) were Albania (G. Qirjako), Armenia (S. Sargsyan), Austria (R. Felder-Puig), Belgium (D. Piette, C. Vereecken), Bulgaria (L. Vasileva), Canada (W. Pickett, W. Craig), Croatia (M. Kuzman), Czech Republic (M. Kalman), Denmark (M. Rasmussen), Estonia (K. Aasvee), Finland (J. Tynjälä), France (E. Godeau), Germany (P. Kolip), Greece (A. Kokkevi), Hungary (Á. Németh), Iceland (Á. Arnarsson), Ireland (S. Nic Gabhainn), Israel (Y. Harel-Fisch), Italy (F. Cavallo), Latvia (I. Pudule), Lithuania (A. Zaborskis), Luxembourg (Y. Wagner), Macedonia (L. Kostarova Unkovska), Malta (C. Gauci), Moldova (G. Lesco), Netherlands (W. Vollebergh), Norway (O. Samdal), Poland (J. Mazur), Portugal (M. Gaspar de Matos), Romania (A. Baban), Russia (O. Churganov), Slovakia (A. Madarasova Geckova), Slovenia (H. Jericek), Spain (C. Moreno), Sweden (L. Augustine), Switzerland (E. Kuntsche), Ukraine (O. Balakireva), and the UK (F. Brooks, C. Roberts).

Funding

K.E.R. was supported by a Frederick Banting and Charles Best Canada Graduate Scholarship from the Canadian Institutes of Health Research and the National Institute of Mental Health (NIMH) Psychiatric Epidemiology Training Program (5T32MH014592-39; PI: Zandi, Peter). FJE was supported by a Canadian Institutes for Health Research operating grant (MOP-133519). G.G. was supported by a Canadian Institutes for Health Research postdoctoral fellowship. AQV holds the Canada Research Chair in Policies and Health Inequalities. FJE holds the Canada Research Chair in Social Inequalities in Child Health.

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